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Social Metabolism, Cultural Landscape, and Social Invisibility in the Forests of Rio de Janeiro

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1. Introduction

Rio de Janeiro is the second largest urban center in Brazil and one of the largest economic and cultural centers of Latin America. Fully 70.7% of its territory is already urbanized and it has about 6.3 million inhabitants. The city is located between the mountains and the life-giving sea - a unique geography that enchants visitors and enamors those that live there. The city spreads between two coastal mountain ranges - the Pedra Branca and Tijuca massifs - and displays specific peculiarities because of these monolithic neighbors (Figure 1).

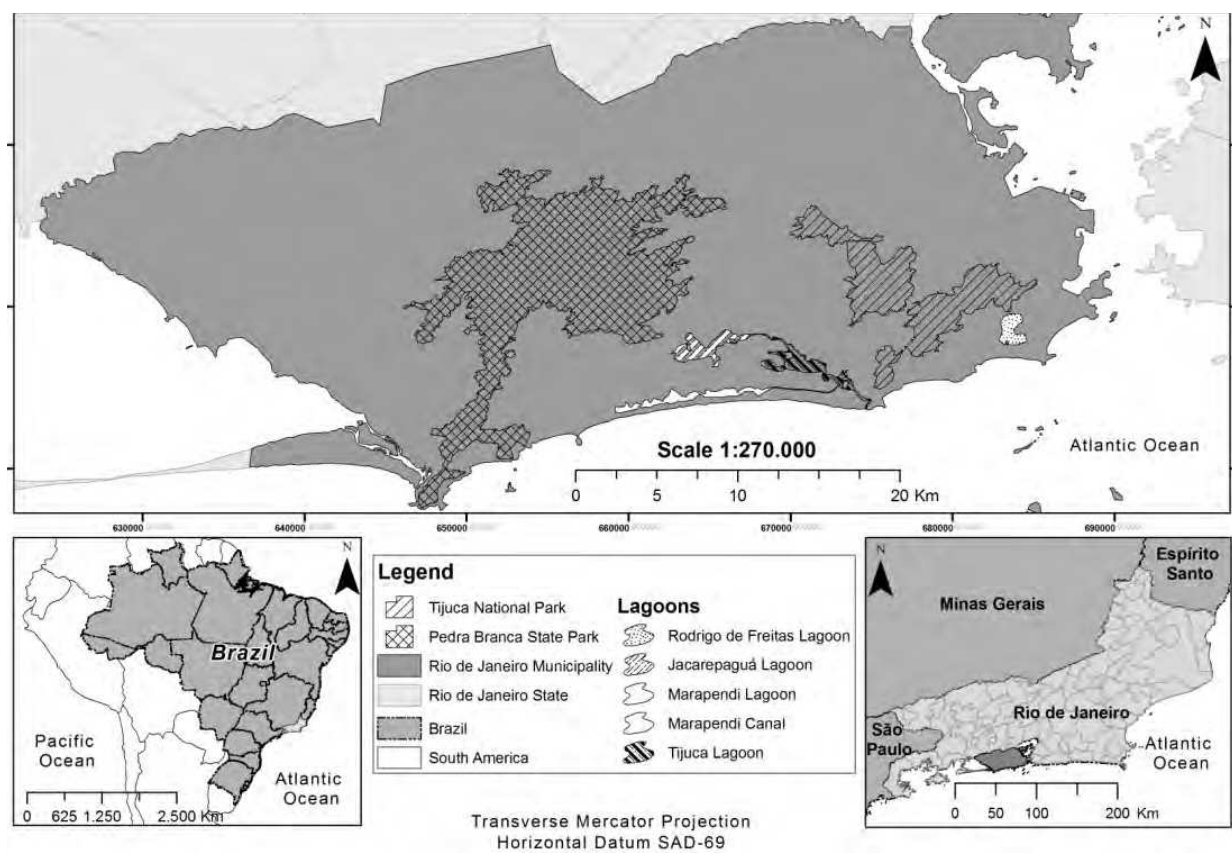


Fig. 1. The municipality of Rio de Janeiro and its main physical features.

The lush Atlantic Forest that covers the mountains in and around the city contrasts markedly with the blue sea and the lagoons scattered throughout the urban landscape. This contrast between natural and anthropogenic landscapes has created the identity of the city of Rio de Janeiro, with its forests and lagoons appearing as pristine landscapes separated from the artificial city.

But these forests are actually very far from being pristine landscapes, and the process of landscape transformation has a long history in this area. Among the analytical categories used in many social sciences, the concepts of “landscapes” and “landscape transformation” have a special place. The concept of landscape is closely linked to the polysemic concept of culture, which Crumley (1994) considered to be the spatial manifestation of human-environmental relationships. The complexity of this concept can be seen in the fact that the landscape is at the same time both a physical reality and a social construct. Landscapes have long been shaped by a history of human management and natural disturbances (Balée, 2006). Understanding the dynamics of these ecosystems requires an understanding of how social and ecological factors interact, and how these interactions change over time. As such, any attempt to understand ecological systems without taking into account human participation is to deny the origins of many of the geographic and ecological patterns observed in present-day ecosystems. In terms of the landscape, that which we now deem to be “natural” may often reflect systems that have been managed for many centuries by historical populations (Oliveira, 2008). Many papers have illustrated that what we currently consider “natural nature” is in reality a vegetational mosaic, due to direct and indirect management of former systems.

Authors from many different disciplines have attempted to address the dichotomous paradigm of nature versus society. Morin (2002), for instance, suggested the theory of complexity for contemporary science; Capra (2006) proposed understanding life through physics, as webs of relationships at different levels; Toledo & Molina (2010) worked with the concept of social metabolism to explain the relationships between society and nature; and Padua (2010) defined environmental history as an open, not reductionist, investigation of the interrelationships between social and natural systems over long periods of time.

The inseparability of society-nature begins with the presumption that humans not only need nature to survive, that they not only transform it and reproduce it, but are transformed by it and are part and product of nature. The history of any society implied in these dialectic and binding relationships, in which men have to adapt to their environment while also adapting the environment to their necessities by way of techniques acquired slowly over time, represent co-evolutionary systems that have resulted in the landscapes that we see today (both “anthropogenic” and “natural”).

Our starting point in examining these interrelationships is the study of the paleo-territories of charcoal producers in the XIX/XX centuries in secondary forests in the mountains of Rio de Janeiro, Brazil. Since the beginning of the XIX century, charcoal had a fundamental role as an energy source for the many activities related to metallurgy. Iron was converted into valuable articles like horseshoes and tools, and by using charcoal forges; stonemasons in the growing city could sharpen their chisels. The urban forests of Rio de Janeiro were the main sources of wood that was to be converted into charcoal, and we discuss here the processes of resource appropriation using the concept of social metabolism – which connects the city and the forest based on energetic demands supplied by that charcoal.

Within this general view, the present chapter examines the historical processes related to human presence in the ecosystems now contained within the city of Rio de Janeiro, and evaluates the importance of the historical appropriation and modification of that landscape.

2. Social metabolism: The interface between society and nature

Analogies and metaphors of natural and social organisms help us to better understand how nature and society are related. Fischer-Kowalski (1998) used the term social-economic metabolism to describe the material and energy fluxes between society and nature. In biology, metabolism implies the sum of all the chemical processes that occur within a living organism, including growth, energy production, useful work, locomotion, reproduction, and excretion. The analogy with social systems is therefore appropriate in terms of the reproduction of human populations as well as economic production and consumer processes that require fluxes of material and energy. According to this author, these processes are subject to the laws of thermodynamics and other physical limitations, including the availability of space.

For Toledo & Molina (2007), the metabolism of society and nature constitute the way in which human societies produce (and reproduce) the material conditions necessary for their existence. Human beings organized into societies (and independent of their particular spatial/temporal situations) appropriate, distribute, transform, consume, and excrete materials and energy coming from the natural world. These authors proposed the study of social metabolism based on five processes: appropriation, transformation, distribution, consumption, and excretion. Appropriation constitutes the specific concrete moment in which humans interact with nature through work and it represents the ecological dimension of the production process itself. This represents the internalization or assimilation of natural resources by the social organism (Toledo & Molina, 2007) and these operations have real effects on nature (Molina, 2010), as they occur in conformity with the biological and physical laws that direct natural systems.

As such, and from an ecological point of view, fluxes of material and energy within systems (whether natural or anthropogenic) follow the laws of thermodynamics. According to the first law of thermodynamics, energy can neither be created nor destroyed, only transformed. From this follows the second law, in which each energetic transformation suffers losses in the form of heat (entropy). Entropy is a measure of dissipated energy that is no longer available for work (Odum, 1988). As a consequence of these two laws, energy flow is unidirectional and there must be a continual input of energy into this ecosystem, a flow that originates from solar energy.

The metabolism of a society is likewise subject to the principles of thermodynamics in terms of social exchanges. A relevant point in the understanding of social metabolism is the association of the laws of thermodynamics with the question of physical space. The first law of thermodynamics is essentially an affirmation of the principle of energy conservation in thermodynamics systems (Fermi, 1956). The second law of thermodynamics can be understood in terms of the degradation of energy within the system - no energetic transformations can occur without a loss of energy in the form of heat (entropy). Entropy grows as the numbers of possible trajectories resulting from the increasing complexity of the system (Herscovici, 2005). The metabolism of a society incorporates the principles of

thermodynamics for social exchanges. Energy and material are transformed, disassembling and reorganizing for other uses, articulating themselves in what are called ecological pyramids.

Ecology uses the concepts of biomass, energy, and nutrient pyramids to express the changes at the different stages of energy transformation. The accommodation of a trophic web in an ecological pyramid also presupposes spatial relationships between each of its levels – as a function of heat loss that occurs at each stage of energy transformation. A practical example would be an area of 40,000 m² that can produce a given quantity of rice (representing the producer level of the pyramids) sufficient to feed 24 people (primary consumers) during one year. If this same area were used for animal pasture (primary consumers) the quantity of meat produced could feed only a single person during a year (secondary consumer) (Sariego, 2002). Therefore one must be aware of the fact that fluxes of material and energy have territorial costs (Casado & Molina, 2007). In the same way, human labor must be considered an integral part of the metabolism of a social group or of an economic activity. Although physical work can be considerably reduced by way of technological artifacts, the interactions of these fluxes continue to be biophysical processes and therefore subject to the laws of thermodynamics (Winiwarter, 2010).

The concept of social metabolism therefore seeks to analyze a given production system and its conjunction at a given historical moment with social, ecological, and physical dimensions.

3. The city of Rio de Janeiro in the 19th and 20th century and its energetic demands

Until the beginning of the 19th century, the Tijuca and Pedra Branca Massifs near the city of Rio de Janeiro were largely used to produce sugarcane and for extracting lumber and firewood. In the 18th century, coffee began to be planted on the Tijuca Massif (and on a lesser scale on Pedra Branca Massif). Starting in 1860, the government began efforts to recuperate water sources on the Tijuca Massif, and at about this same time charcoal production began to increase on the Pedra Branca Massif (Table 1).

Massif	Century		
	XVII	XVIII	XIX / XX
Tijuca	Wood, firewood, sugarcane	Wood, firewood, and principally coffee	Water supply for the city
Pedra Branca	Wood, firewood, sugarcane	Wood, firewood, sugarcane	Sugarcane, firewood and charcoal

Table 1. Principal economic uses of Tijuca and Pedra Branca massifs near the city of Rio de Janeiro.

The forests of the Pedra Branca Massif have furnished firewood to sugar mills since the 17th century. Firewood was fundamental to the functioning of these mills during the colonial period (Engemann et al., 2005), and to have an idea of the impact of the sugar industry on the Atlantic Forest one must consider that the Capitania of Rio de Janeiro alone had 131 sugarcane mills functioning at the beginning of the 18th century (Abreu, 2010).

The evolution of the city of Rio de Janeiro and its urban forest from the point of view of charcoal production requires the examination of the energetic and material needs of that society. The functioning of the city was largely dependent on charcoal as an energy source. It was the principal energy matrix of the time and was used: a) to prepare foods (as well as for ironing clothes); b) for transportation, as the city was being paved at that time and large numbers of mules and work horses were being used, and their horseshoes were made in small blacksmiths shops scattered around the city. Also, starting in 1858, railroads were being built and their locomotives were largely fueled by charcoal; c) in industry (principally glass and textiles in the 19th century); d) for the production of tools and utensils; e) in smelting, in the process of direct reduction of iron ore (removal of oxygen); and f) in civil construction (possibly one of the most significant uses, as all stone masonry involved tempering and sharpening iron tools). Thus large amounts of charcoal were used in Rio de Janeiro at this time, and its production greatly influenced the evolution of the material dialectic between the city and the forest.

4. The social invisibility of the charcoal workers

Who were the people who made charcoal? What made this rather marginal activity (in relation to the central economy) expand so greatly at that time? It should be first pointed out that this was a portion of human population that was largely socially invisible. In a society that still retained a slave mentality (even after the abolition of slavery), manual work was considered degrading and only the poor could not avoid it. With the exception of Magalhães Corrêa (1933), who made a point of describing the lives of charcoal workers in his book, they were practically forgotten by the writers of their time. Some expressions still used today in Portuguese demonstrate the bias that existed against these men. If you wanted to say, for example, that someone had dirty hands, you would say that they had "charcoal maker's hands". But we can go even further: this social invisibility was based on profoundly prejudiced ideas and associations; the color of the workers (largely blacks), the dirty nature of their work and the remote locations where these people worked – also attributed to their race.

At the beginning of the 19th century, the non-slave population was compressed between two extremes on the social scale - slave owners and slaves - and they had only marginal and uncertain occupations (or no occupations at all), thus drifting, residual social group that orbited around organized society (Becker & Egler, 1998). Thus work, a necessary condition for survival, was guided by social demands. Heavy industry was only beginning in the mid-19th century, and even when extensive industrialization had taken hold, there was a lack of qualified labor and internal commerce showed it to be a plausible source of income.

However, this social invisibility was a two-way street, principally as it refers to the forests of Rio de Janeiro. On one side, society did not recognize these slaves' and former slaves' rights to citizenship. On the other hand, this marginalized group had the ability to escape to safe havens within the forest in times of conflict or abuse at the sugar plantations. The exploitative nature of slavery is most apparent in its system of rewards and frequent punishments (Fogel & Engerman, 1979). In times of heavy punishment or conflict, many slaves escaped and formed small fugitive communities (*quilombos*), generally settling in the forests (Gomes, 2005). They then became small scale subsistence farmers who would also

trade goods with white society. The mountains surrounding Rio de Janeiro supported the establishment of these *quilombo* communities. Today, ruins of *quilombo* settlements, homes and charcoal producing sites can be found in the middle of the urban forests still covering those hills as seen in figure 2.



Fig. 2. *Quilombo* ruin (possibly a home foundation) found within the forest of the Pedra Branca Massif.

It is very possible that charcoal production was the work of newly freed slaves or small planters, and was not actually an integral part of the sugar mill productive system. Even before the abolition of slavery in Brazil in 1888 the slaves took little part in productive activities. With abolition, the blacks came to constitute a large contingent of unemployed workers, without sufficient resources for their own survival. As such, charcoal production allowed for certain independence. This makes sense. In the 19th century the materials required for charcoal production were minimal – just an axe, a hoe and a rake. They used baskets made of bamboo and vines as can be seen in the painting by Debret made in 1827 (figure 3). References to cloth sacks were only made much later, in the 1920s (Corrêa, 1933).



Fig. 3. *Charcoal sellers*, by Jean Baptiste Debret (1827).

5. Metabolic processes involved in charcoal production

5.1 Appropriation and transformation of forest resources

Appropriation is a process by which members of a society appropriate and transform ecosystems to satisfy their necessities and desires. In addition, it refers to the concrete and specific moment in which humans articulate themselves with nature through work; it therefore constitutes the first step in the general process of social metabolism (Toledo & Molina, 2010). As such, the manner which this appropriation is performed, exactly how the natural elements are extracted from nature, will determine the effects of those actions on nature. This is the material basis of all social production. The quantification of the appropriation of forest resources reflects, in turn, not only the demands of society for certain resources but also the economic necessities of the appropriation unit (in this case, the charcoal workers)¹.

¹ *Sensu* Toledo & Molina (2007). The appropriation units (P) operate as resource transformers, converting basic resources into socially consumable energy fluxes. They can be businesses, cooperatives, families, a community, or just one individual.

Historically, wood has always been used as a primary energy source for human necessities. Its transformation into charcoal increases its caloric value while reducing its mass, making transport over long distances relatively easy. Unlike coal, charcoal can be produced locally and its production costs are almost negligible, consisting exclusively of the labor invested in its fabrication (Olson, 1991).

Charcoal production was undertaken in the forest itself by way of a primitive process of distillation of the firewood. The construction of a charcoal kiln required cleaning and leveling a piece of ground using just a hoe, and slightly altering the local landscape (figure 4). This appropriation of forest resources by the charcoal makers was an extremely simple process, even considering the technology of the time. A small oval plateau (35 – 50 m²) would be cleared and leveled at a chosen spot on the forest slope using a hoe (Oliveira et al. 2012). The wood used was not selected according to species, and any tree was considered appropriate (Corrêa, 1933).

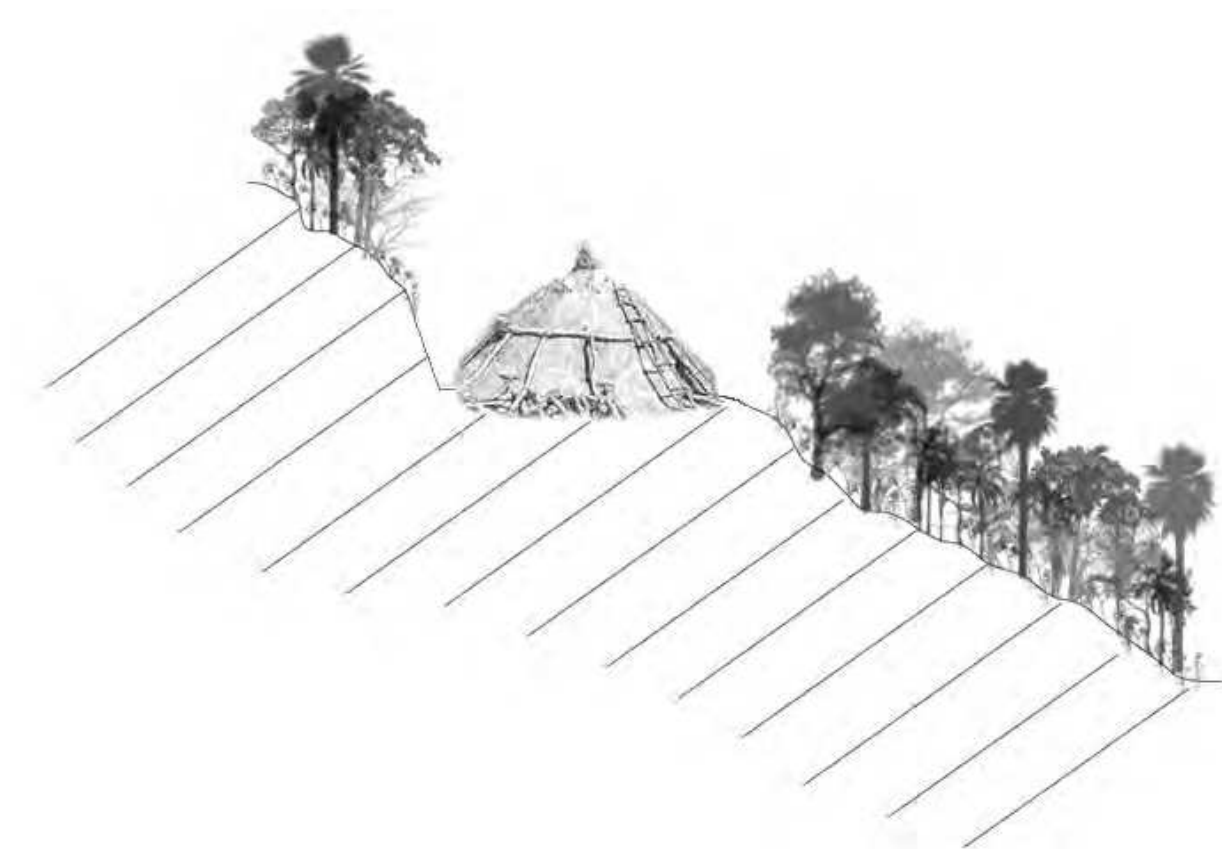


Fig. 4. Scheme of a charcoal kiln, showing the cut into the hillside.

After leveling small plateaus, the firewood was piled up in the form of a large cone, with the vertex composed of smaller pieces of wood (figures 5 and 6). The cone was then covered by leaves and a layer of humid soil (about 30 cm thick) leaving only a central chimney as well as some lateral orifices to allow the smoke to exit. The numbers of lateral openings could be increased or decreased to control the combustion rate. The burning process could last several days, and the charcoal makers would have to be present both day and night to avoid rapid combustion (which would result in the loss of all the charcoal) (Corrêa, 1933).

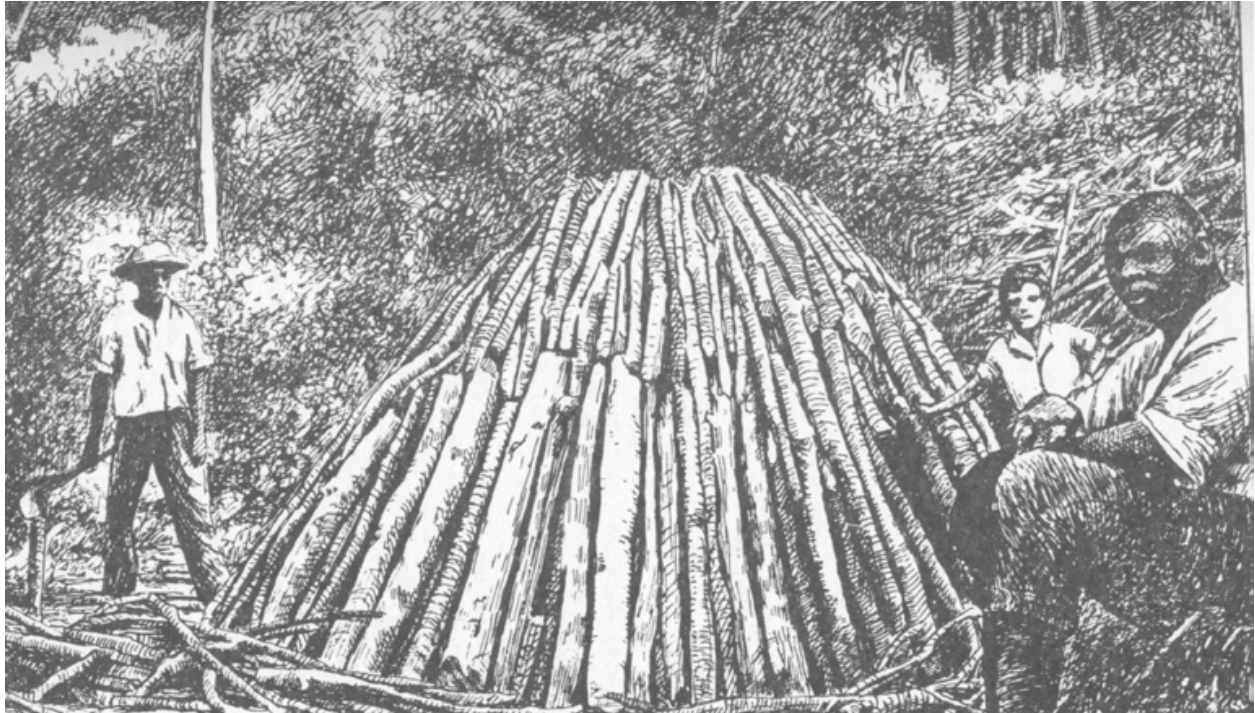


Fig. 5. Constructing a charcoal kiln (Magalhães Corrêa, 1933).



Fig. 6. A 19th-century charcoal kiln in the slope of Pedra Branca massif.

The use of these resources was studied during field work by the authors in a forested area of about 400 hectares located on the slopes of the Pedra Branca Massif (between 20 and 600 m a.s.l.). We searched the area for vestiges of earlier charcoal fabrication in the form of kiln plateaus, alterations in the local flora, the presence of exotic plant species, archaeological objects, etc. We used our experience as ecologists to identify these remains in the region, and approximately 50% of the total area was covered. The searches for these vestiges had many limitations, however, such as the accentuated declivity of certain sites, dense vegetation, and the physical limitations of attempting to survey a large area. As such, the true number of the vestiges of these activities must be significantly greater.

Fully 150 years after clearing, the forests have returned but still contain historical records that can aid our understanding of the relationships of the charcoal makers with their environment. Vestiges left in the forest help us to decipher the logic behind the exploration of these resources. The remnant signs of the charcoal makers were not regularly distributed along the forest slopes. Localities with talus deposits (large blocks of fallen rocks covering large areas of the forest floor) showed few signs of past charcoal-making activities. This was probably due to two factors: a) the difficulty that the workers would have had in transporting logs along those slopes, and b) the impossibility of constructing plateaus on

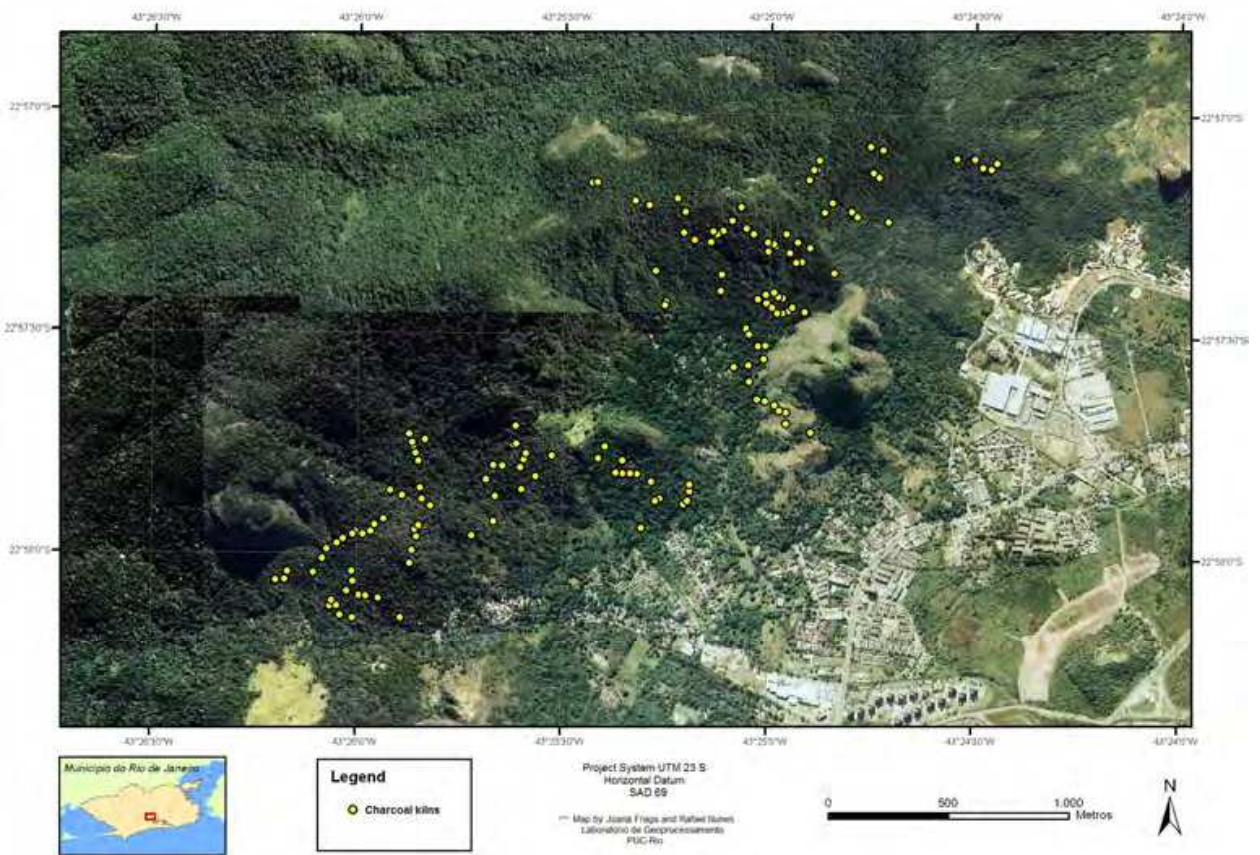


Fig. 7. Localization of sites of charcoal-kilns remnants (in yellow) on the southern slopes of the Pedra Branca Massif, Rio de Janeiro.

these blocks of fallen stones. 168 abandoned charcoal kilns were identified during the fieldwork, and were located as in figure 7. But there must have a much greater number of vestiges in the forest. However we could not find out them due to the terrain's difficulties. Our fieldwork indicated that the Pedra Branca Massif had been intensely occupied and used from the 19th century until the middle of the 20th century. It would be extremely difficult to evaluate the dates of each charcoal producing site, but most of them showed evidence of intense incorporation of carbon fragments throughout the soil profile, which suggests they are quite old – dating at least to the beginning of the 19th century.

5.2 Distribution and consumption of the goods produced

The processes involved in the distribution of goods initiate when an appropriation unit stops producing everything it consumes and consuming everything that it produces - leading to economic exchange (Toledo & Molina, 2007). Different historical times had specific consumption demands, as well as different technical possibilities and resources for their production. What is produced and how it is produced follow from those factors (time, demand, and technical ability). As such, an historical-cultural context is fundamental to understanding the processes involved in each of these systems.



Fig. 8. Charcoal transportation in the mountains of Rio de Janeiro with the use of mules (by Jean Baptiste Debret, 1827).

Charcoal was distributed over relatively short distances, and involved transport by mules in the mountainous parts of the route, basically from the Pedra Branca Massif to the city center (about 40 km) where it was sold (Fig. 8). According to Corrêa (1933), charcoal was transported from the forest to the city principally by mule trains, and later by trucks.

The charcoal was destined for different appropriation units, from household stoves to growing industries. At that time, there was no electrical energy or petroleum (for energetic consumption), and charcoal was a highly sought after energy source, as can be seen bellow.

Consumption	Destination of the charcoal	Relative volume of the required charcoal
Domestic	Stoves, ovens, and irons	low
Transport	Locomotive fuel	medium
Manufacturing	Four shoes, axes backspace, hoes, diverse utensils (chains, wheels, hinges, etc.)	high
Industry	Industries (textile, gunpowder, glass, etc.)	high
Metallurgy	Direct reduction of iron ore (removing oxygen)	high
Civil construction	Sharpening masonry tools	very high

Table 2. Consumption of charcoal in Rio de Janeiro in the 19th century

It is very probable that civil construction was one of the largest charcoal consumers (especially by stonemasons). Whenever stone work was done, it was necessary to sharpen the chisels and other cutting tools used. In constructing a meter of doorframe (as can be seen in figure 9) a mason would need approximately 30 chisels. When blunted, they could not be sharpened on a sharpening stone (or they would lose their temper) and would have to be heated in a forge and reshaped on an anvil. Forges using charcoal multiplied throughout the city with the exponential growth of civil construction at the turn of the 19th century.

The production of charcoal, from its appropriation to final consumption, follows the second law of thermodynamics. In its transformation by way of oxygen-limited combustion there is reduction of the mass of the material (firewood) but with an energetic increase (charcoal). The change in the form of this energy (from that contained within a living tree in the form of cellulose to that of charcoal) is induced by heating (oxygen deprived combustion), and the caloric content of charcoal per unit of weight is almost three times greater than that of firewood. The energy contained in the biomass of one hectare of standing forest is much less concentrated than that of the charcoal that the same hectare furnished. That is, the forest represents a diffuse energy source, while charcoal represents concentrated energy.



Fig. 9. Detail of a doorframe constructed in the 17th century in Rio de Janeiro.

6. Social metabolism and cultural landscapes

Together with Historical Ecology, the study of social metabolism helps to understand the interactions through time between societies and environments and the consequences of these interactions for understanding the formation of contemporary and past cultures and landscapes (Balée, 2006).

The growth of Rio de Janeiro in the 19th century depended on this "food" source, just as a living organism needs to feed in order to generate energy for its development. Material was transformed into energy to supply social demands "from the most humble dwelling to the most important industry" (Corrêa, 1933). These demands drove the relationships between society and the natural environment around it, and nature was viewed at that time essentially as a source of basic resources.

This relationship contributed to the production of the culturally modified landscape of Rio de Janeiro, transitioning from a highly urbanized central area to forests at the urban edge, many kilometers from the city center. The connections between the city and the forest were dominated by the energy paradigm utilized. Although the forest has

functionally recuperated through ecological succession since the abandonment of these activities, it still retains the marks of this history in the alterations of its flora, in the cycling of nutrients, etc.

As urban growth was based on energy derived from charcoal, forests had to be cut to supply this demand. However, the process of transforming of this material (forest biomass) into useful energy for the city did not prevent the forest from eventually recuperating, and it has not been used to supply energy for the city for at least 60 years. This area is currently part of the Pedra Branca State Park (created in 1974) and now supplies what are called "ecological services" – which Toledo & Molina (2007) likewise consider a type of appropriation. These services include: climatic regulation, leisure, education, scientific investigation, among others.

The technical evolution of transportation systems, new sources of energy (principally fossil fuels) and a changing view of nature allowed the emergence of another cultural landscape configuration. These forests were able to recuperate (through ecological succession) because of social and technical advances and political and economic decisions regarding land-use (which were influenced, in turn, by evolving national and international political structures).

Pádua (2010) observed that the biophysical, social, and cultural spheres are always present, and that "in these different cases they are open systems that become modified as history progresses. The components of these interactions – all of which are relevant, even though at different levels – construct, destroy, and reconstruct in numerous material and cultural forms".

The Pedra Branca Massif forest, as a resource exploited in the 19th and 20th centuries, was integrated into the processes of social metabolism. As such it was subject to the laws of thermodynamics and was incorporated into what are called ecological pyramids, with solar energy being fixed by the plant community through photosynthesis, and later undergoing a concentration of energy by changing form (woody material to charcoal).

The same tendency of concentration is also seen at the landscape level, especially considering the cultural landscape (Harberl et al. 2006). In order for the city to attain elevated population levels it was necessary (among other factors) to concentrate its energy sources. This could only occur with the availability of extensive territorial areas where energy was held by large standing forests. Consequently, the population that exploited these resources (the charcoal makers themselves) were necessarily distributed throughout the area to exploit those disperse resources². The pattern of territorial occupation by the charcoal makers demonstrated this tendency of dispersal within the forest, and reflected difference between the spatial dimensions of the forest and the city – with the former, as a provider of energetic resources, covering an area considerably larger than the latter.

This situation implies, however, an increase in entropy according to the second law of thermodynamics. That is, when more work is expended, more energy is lost, and a large quantity of this energy is lost as heat and is not available for productive processes.

² We encountered the ruins of the homes of 33 charcoal makers in the Pedra Branca mountains.

Entropy is a complex subject and, as Georgescu-Roegen (2004) noted, it isn't easily understood even by physicists themselves. Its importance as a physical law can be seen if we consider the growing complexity of our modern system and, principally our current sources of (nonrenewable) energy. The consideration of this concept in studies concerning the appropriation of ecosystems may aid our understanding of the consequences of increasing this entropy. The fluxes of material and energy in contemporary society are becoming increasingly complex, which implies that their repercussions will likewise be complex.

A final point to highlight in relation to landscape formation: charcoal exploitation in the 19th and 20th centuries did not cause permanent deforestation, only the extensive formation of secondary forests. Of the 168 charcoal pits discovered, only 5 (2.3%) were located in open areas (grassland or pasture). The other 97.7% were found deep within the forested hillsides in various stages of ecological succession. It appears that the most significant ecological consequence was a possible reduction in biodiversity; however biomass was left relatively unchanged.

7. Final considerations

The historical character of a landscape will constitute a significant factor in its evolution, which obliges us to reflect on how these fluxes take place today – as the present represents the past of the future. As such, we will need to better understand the impacts our collective actions have on our natural resources, and consequently on future survival space – ours and all living creatures.

In regards to the social metabolism of the energetic demands city of Rio de Janeiro during the 19th and 20th centuries, the use of firewood to produce charcoal did not apparently resulted in significant permanent negative effects. This was due to a number of factors that modified society over time, such as the appearance of new energy sources, technological advances, evolving cultural views of nature, and the possibility of extending the distances over which consumer goods could be acquired. These factors permitted the regeneration of the forests and also produced the highly complex city of Rio de Janeiro. What is the price, however, that the areas that furnish resources to the city of Rio de Janeiro pay today in terms of their social ecological systems so that the city can maintain its standing forests?

A final consideration should be made in relation to the historical character of the socio-ecological systems. Temporal considerations retain significant relevance in the evolution of these systems, which raises the question of the differences between human and social time scales and the time scales of ecosystems in regards to change. The acceleration of fluxes and the compression of space and time by contemporary society impose a rhythm on it that is very different from the rhythms of natural laws. This acceleration places growing pressure on ecological systems by causing them to function at paces that makes it impossible for them to fully regenerate – and raises the question of how long can they last? Evolving technologies may optimize this relationship, but we cannot evade natural and physical laws.

Finally, it is important to consider the social contexts in which different time periods determine their own paradigms, and what will be the consequences for the ecosystem (and therefore society). The formation of cultural landscapes involves co-evolutive dynamics and co-dependence among social and natural systems. These systems communicate and mutually influence each other in both symbolic and material spheres. The city of Rio de Janeiro is therefore inseparable from its forest, be it by direct exploitation of its resources, or by its "ecological services". This demonstrates the existence of a "forest – culture" that coexists without opposition to "forest –nature".

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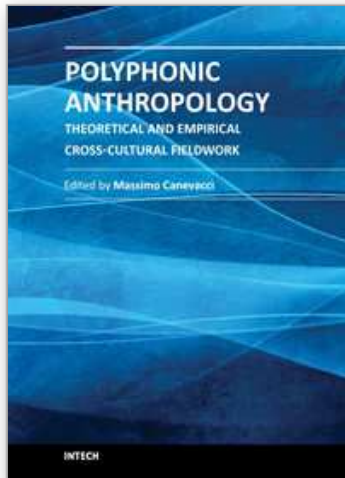
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